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Efficacy of Dexmedetomidine as an adjuvant to 0.5% Ropivacaine in Supraclavicular Brachial Plexus Block for Postoperative Analgesia

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Abstract: ***The supraclavicular technique was used by Kulenkampff in 1912 revealed that the nerves supplying the arm and the forearm are geographically grouped closely together in the brachial plexus and a single injection could provide analgesia for the whole limb. The supraclavicular route is easy to perform, small volume of local anaesthetic solution is required as three trunks are compactly arranged resulting in a rapid onset of reliable blockade. Amongst all local anesthetic agents used in brachial plexus block, Ropivacaine has less cardiovascular and central nervous system toxicity as compared to others and is used commonly in brachial plexus block. It was shown that Dexmedetomidine delays duration of post operative analgesia.In present study, an attempt was made to undertake the study of post operative analgesia by Ropivacaine with Dexmeditomidine as an adjuvant in supraclavicular brachial plexus block.***

Keywords: Dexmedetomidine, Ropivacaine ,supraclavicular brachial plexus block ,postoperative analgesia

1. Introduction

In upper limb surgeries regional anaesthesia is a better option for elective as well as emergency procedures on the hand, forearm and elbow. The supraclavicular technique was used by Kulenkampff in 1912 revealed that the nerves supplying the arm and the forearm are geographically grouped closely together in the brachial plexus and a single injection could provide analgesia for the whole limb.(1) Brachial plexus block can be done with single drug avoiding multidrug therapy as used in general anaesthesia .This technique avoids all complications of general anaesthesia like interference with general body physiology, stress response to intubation, loss of protective reflexes and operation theatre pollution.Numerous routes to perform brachial plexus block have been described, like Supraclavicular, Interscalene, Infraclavicular and Axillary. The supraclavicular route was used in this study as it is easy to perform, small volume of local anaesthetic solution is required as three trunks are compactly arranged resulting in a rapid onset of reliable blockade.Lanz et al(1983) showed that blockade of the brachial plexus with a supraclavicular technique directed near the first rib provides the most reliable, uniform, and predictable anaesthesia for the upper extremity.(2) Ropivacaine the group of local anaesthetic, the pipecoloxylidides which has a propyl group on the piperidine nitrogen atom. It causes reversible inhibition of sodium ion influx and thereby blocks impulse conduction in nerve fibres. The plasma concentration of Ropivacaine depends on the total dose administered and the route of administration, as well as the haemodynamic and circulatory condition of patient and vascularity of the administration site The side effects associated with Ropivacaine include hypotension (32%), nausea (17%), vomiting (7%), bradycardia (6%) and headache (5%), which are seen after various routes of administration.(3)Ropivacaine has less cardiovascular and central nervous system toxicity as compare to other drugs used. Less systemic toxicity is due to its stereo selective properties and less lipophilicity. Dexmedetomidine is the d-enantiomer of medetomidine. It is described chemically as (+) ¡V 4 - (s) - (1 - 2, 3 - dimethylphenyl) ethyl - 1H - imidazole monohydrochloride. Its empirical formula is C13H16N2 HCL, and its molecular weight is 236.7. It shows a high ratio of specificity for alpha 2 receptor.(alpha 2\alpha 1 1600: 1)compared with Clonidine (alpha 2/ alpha 1 200:1) making it a complete alpha 2 agonist (8 times more specific for alpha 2 receptor).(4,5)Esmaoglu et al31 (2010)carried out randomised, double blinded trial in which Dexmedetomidine added to Levobupivacaine for axillary brachial plexus blockade shortened the block onset time, prolonged the duration of motor and sensory effects and extended post operative analgesia. In British journal of anaesthesiogy, Marhofer D. et all (2012) published a volunteer study of Dexmedetomidine as an adjuvant to Ropivacaine which prolonged the effect of peripheral nerve block. (6)The study was performed in 36 volunteers with 3ml Ropivacaine 0.75% plus 20 microgram Dexmedetomidine. It was shown that Dexmedetomidine delays duration of post operative analgesia.In present study, an attempt was made to undertake the study of post operative analgesia by Ropivacaine with Dexmeditomidine as an adjuvant in supraclavicular brachial plexus block. In this study, we used Dexmedetomidine 1 microgram/kg approximately 50 microgram (0.5 ml) as an adjuvant to 0.5% Ropivacaine 30 ml (total volume 30.5 ml) in supraclavicular brachial plexus block.We evaluated the onset of sensory block and motor block, tourniquet discomfort,intraoperative haemodynamic stability and postoperative analgesia in single shot supraclavicular brachial plexus block.We also assessed duration of recovery for sensory block,motor block, intraoperative or postoperative complications if any in both groups.

Study Type
The study type of the research project will be prospective type.

Aims and Objectives
This randomized control trial study was undertaken at Government Medical College and Hospital, during the year 2012-2014, in 60 patients undergoing orthopedic surgeries of forearm.

Comparative study was done between Group R- 30 ml 0.5 % Ropivacaine + 0.5 ml normal saline (total volume 30.5ml) and Group RD- 30 ml 0.5 % Ropivacaine with Dexmedetomidine 1 microgram/kg (approximately 50 microgram or 0.5 ml) (total volume 30.5 ml) in Supraclavicular brachial plexus block.

Following parameters were studied:-
1) Onset of sensory block
2) Onset of motor block
3) Duration of postoperative analgesia
4) Complications and its incidence
5) Consumption of analgesics in first 24 hrs post operatively
6) Evaluation of technique by surgeons and patients

2. Methodology

The patients posted for forearm surgery were included in this study. Sixty patients of both sex and age group 18 and above and weighing 50 to 70 kgs were selected. A detailed preoperative assessment of all patients was done prior to surgery. Patients of ASA grade 1, 2 and 3 were included in the present study.

Selection Criteria
1) Patients undergoing elective and emergency forearm surgeries
2) ASA grade 1 and 2 and 3
3) 18 yr old and above
4) Weight between 50- 70 kg.

Detailed clinical examination and investigations were done preoperatively. Patients having history of hypersensitivity to Ropivacaine or Dexmedetomidine, coagulopathy, local infection, fever, chest injuries were excluded from this study. Patients were randomly assigned to 2 groups:-

In group R (Ropivacaine) (n=30): who received brachial plexus block with 30 ml of 0.5% of Ropivacaine +0.5ml normal saline(total volume 30.5 ml).

In group RD (Ropivacaine + Dexmedetomidine) (n=30): who received brachial plexus block with 30 ml of 0.5 % of Ropivacaine with Dexmedetomidine1microgram/ kg.(approximately 50 microgram or 0.5 ml) (total volume 30.5 ml). Written valid informed consent was obtained. NBM status was confirmed. Patient received Tablet Ranitidine 150 mg orally 2 hours prior to surgery. Patients were provided anxiolysis and sedation, on table, with Inj. Midazolam ¡V 0.02 mg/kg body wt. NIBP, Cardiac monitor & pulse oxymeter were applied. Intravenous line was secured with 18 G angiocath in large peripheral vein. Oxygen supplementation was started at rate of 5 litres/min. It is important to instruct the patient before performing the block to raise finger as a signal if he felt any change in sensation on the arm to be operated.

The patient was placed in a supine position with the head turned away from the side to be blocked. The arm to be anaesthetized was adducted, and the hand was extended along the side toward the ipsilateral knee as far as possible. In the classic technique, the midpoint of the clavicle was identified and marked. The posterior border of the sternoclidomastoid is palpated easily when the patient raises the head slightly. The palpating fingers can then roll over the belly of the anterior scalene muscle into the interscalanae groove, where a mark was made approximately 1.5 to 2.0 cm posterior to the midpoint of the clavicle. Palpation of the subclavian artery at this site confirms the landmark. After appropriate preparation and development of a skin wheal, the anaesthesiologist stood at the side of the patient facing the patient's head. A 23-gauge, 4-cm needle was directed in a caudal, slightly medial, and posterior direction until a paraesthesia or motor response was elicited or the first rib was encountered. If a syringe was attached, this orientation caused the needle shaft and syringe to lie almost parallel to a line joining the skin entry site and the patient's ear. If the first rib was encountered without elicitation of a paraesthesia, the needle was systematically walked anteriorly and posteriorly along the rib until the plexus or the subclavian artery was located. Location of the artery provided a useful landmark; the needle was withdrawn and reinserted in a more posterolateral direction, which generally resulted in a paraesthesia or motor response. After this, 2-3 ml of drug was injected rapidly after aspiration.

After this, 30 ml of 0.5% solution of Ropivacaine +0.5ml normal saline(total volume 30.5 ml) or 30 ml of 0.5% solution of Ropivacaine with 50£gg inj Dexmedetomidine (total volume 30.5 ml) was infiltrated with repeated aspirations. Needle was withdrawn and gentle massage was done at site of injection.

During the whole procedure patient was monitored for development of any complications like nausea, vomiting, respiratory depression or bradycardia. Pulse, respiration, SpO2 and blood pressure were recorded at 5, 10, 30, 60, 120, 180, 240, 360, and 480 min after completion of the injection.

Postoperatively if patient complained of pain inj. Diclofenac sodium 3 cc (75 mg) intramuscularly was given as a rescue analgesic to relieve pain and for treating vomiting I.V. Inj. Ondansetron 4 mg was kept ready.

Assessments

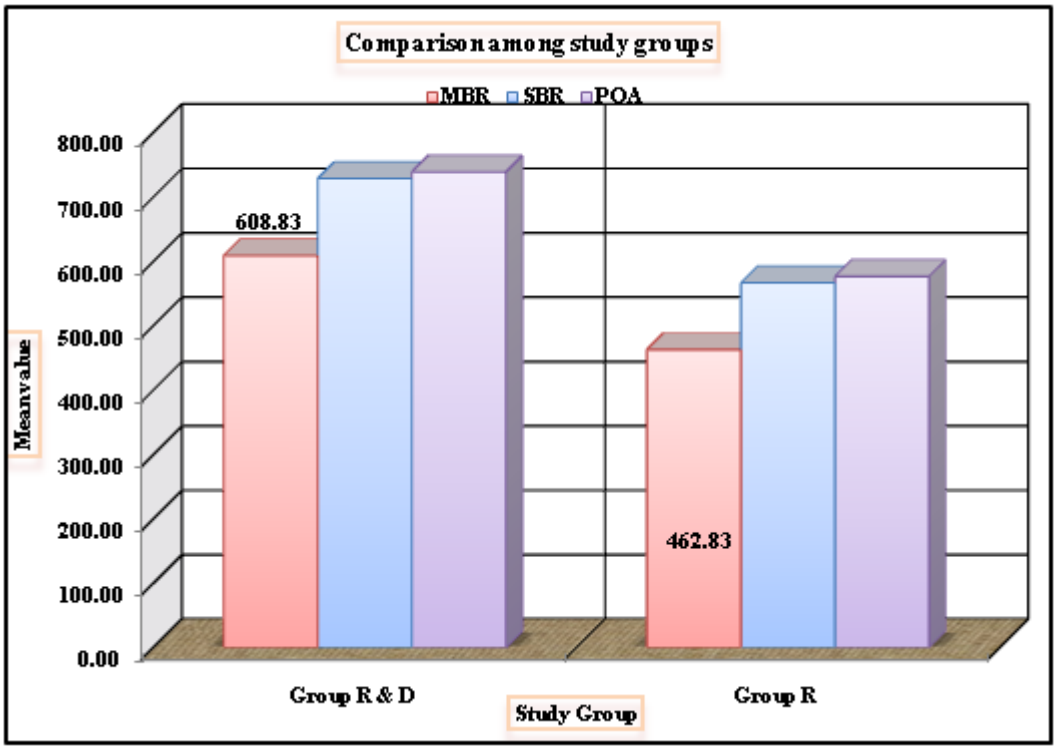
The primary outcome measure was duration of analgesia. This was estimated as the time interval from placement of block till first injection of rescue analgesic. Secondary outcome measures were onset and duration of sensory and motor blockade.
1) Onset of sensory block:
2) Onset of motor block:
3) Total surgical time :-

4) Tourniquet discomfort :-
5) Intra operative condition :-
6) Recovery from sensory block :-
7) Recovery from motor block:-
8) Intraoperative and post operative complications:-
9) Monitoring of vital parameters:-
10) Duration of analgesia:

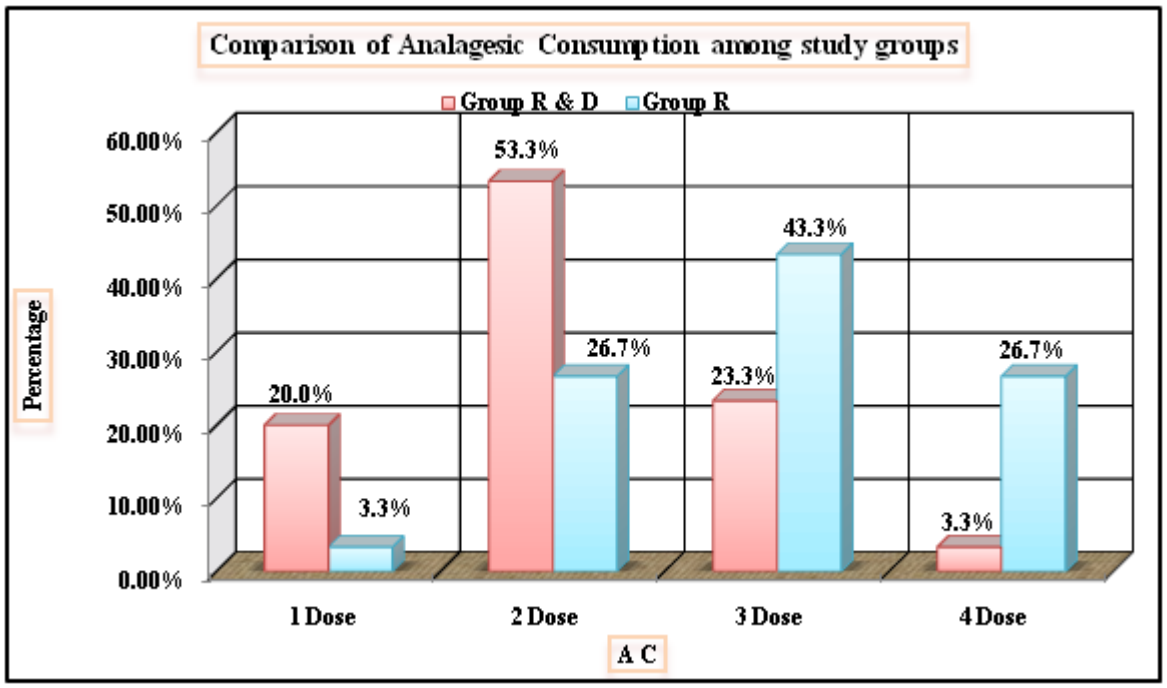
3. Observation and Results

Each group contained 30 patients so there was no statistically significant difference among both groups and both groups were comparable. There were 21 male (76.7%) and 9 female (23.3%) patients in Group R. In Group RD there were 21 males (76.7%) and 9 females (23.3%).Both the groups were comparable with respect to sex and no statistically significant difference was found .(p value 1.00). In Group R 17 (56.7%) patients underwent ORIF and 12 (40.0%) underwent Plating. In Group RD 16 (53.3%) patients undergone ORIF and 13 (43.3%) undergone plating. In both the groups 1 patient (3.3%) underwent Knailing.There was no statistically significant difference in both the groups regarding surgery and both were similar. (p value – 0.965).In both the groups only 3 patients (10.0%) had tourniquet discomfort and 27 patients (90.0%) in both the groups had not tourniquet discomfort.There was no statistically significant difference in both the groups regarding tourniquet discomfort and both were similar. (p value -1.000) The average age in Group R was 34.20 +/- 11.60 years and that in Group RD was 33.17 +/- 9.74 years.Both groups were comparable with respect to mean age and no statistically significant difference was found (p value 0.710).

The average weight in Group R and Group RD was 56.97 +/- 5.41 kgs. Both groups were comparable with respect to mean weight and no statistically significant difference was found (p value 1.000). In the above graph OSB stands for Onset of Sensory Blockade and OMB stands for Onset of Motor Blockade.The mean onset of sensory block in group R was 19.00 +/- 2.83 minutes while, it was 13.00 +/- 2.32 minutes in group RD. The difference was statistically significant with earlier onset of sensory block in group RD. (p value - < 0.001).

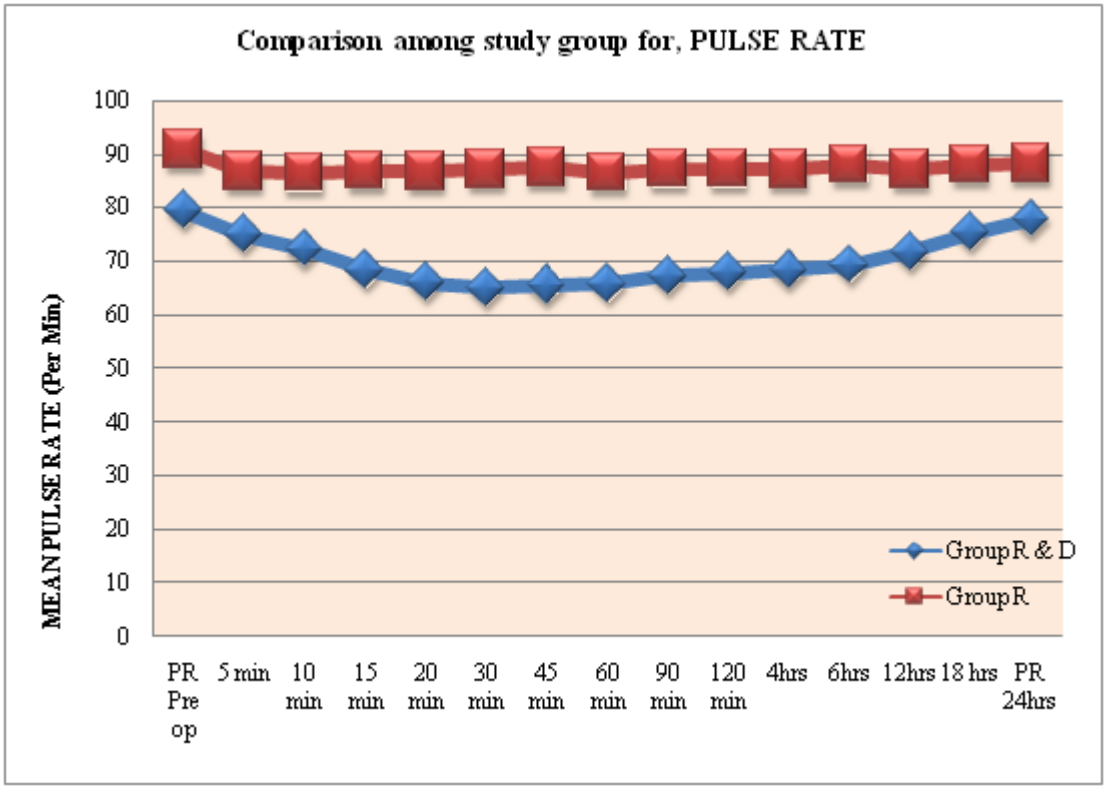


The mean onset of motor block in group R was 24.10 +/- 2.40 minutes while, it was 19.80+/-1.90 minutes in group RD. The difference was statistically significant with earlier onset of motor blocks in group RD. (p value < 0.001). Mean time of recovery from motor block in group R was 462.83 +/- 15.01 minutes while, it was 608.33 +/- 10.23 minutes in group RD. The difference was statistically significant with recovery from motor block was delayed in group RD. (p value < 0.001). Mean time of recovery from sensory block in group R was 566.67 +/- 24.89 minutes while, it was 728.83+/-10.23 minutes in group RD. The difference was statistically significant with recovery from sensory block was delayed in group RD. (p value - <0.001).

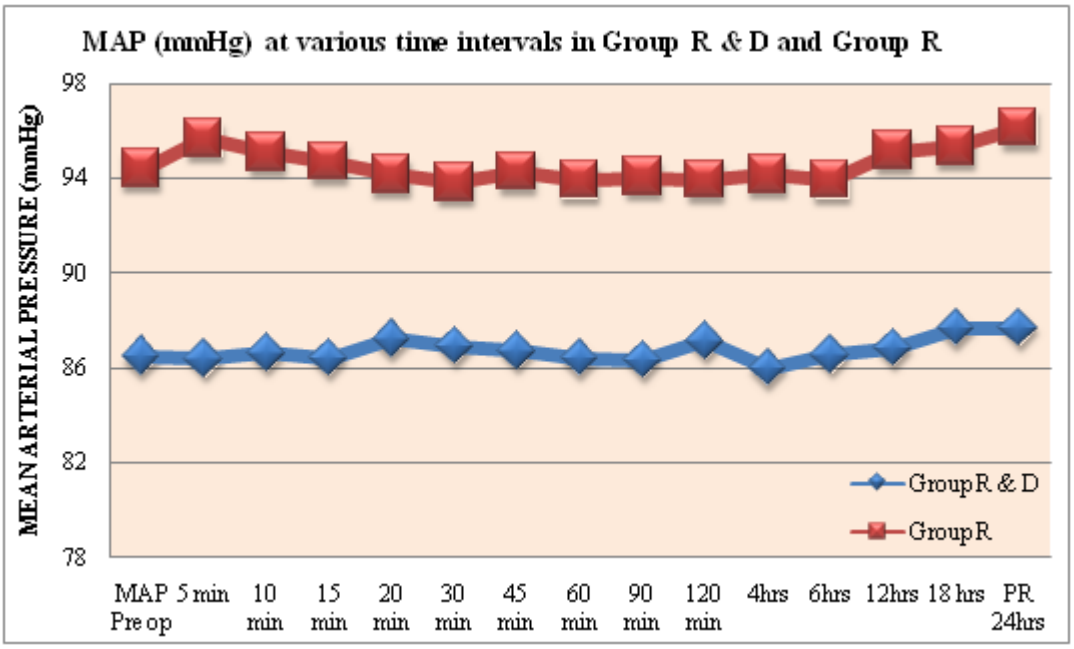


Mean time of post operative analgesia in group R was 576.67 +/-24.89 minutes while, it was 738.83 +/- 10.23 minutes in group RD. The difference was statistically significant with time of post operative analgesia was delayed in group RD (p value -< 0.001).

Patients in Group R required 1 analgesic within 24 hours postoperatively. While 8(26.7%) patients required 2 analgesics, 13 (43.3%) patients required 3 analgesics, 8 (26.7%) patients required 4 analgesics within 24 hours postoperatively. In Group RD ,6(20.0%) patients required 1 analgesic, 16(53.3%) patients required 2 analgesics, 7(23.3%) patients required 3 analgesics,1(3.3%) patient required 4 analgesics within 24 hours postoperatively. There was significant statistical difference present with respect to analgesic consumption within 24 hours and less number of analgesics were required in Group RD. Monitoring of pulse rate was done and data was recorded for the groups at preoperative period and 05,10,15,20,30,45,60,90,120 minutes ,4,6,12,18,24 hours after giving block. On comparison statistically significant difference was found in both groups with respect to pulse rate (p value < 0.05)



In group RD pulse rate was maximaly reduced after 30 minutes after giving block and was normalised to base line after 18 hours as compared to group R.Lowest pulse rate noticed was 65 / minute in group RD.In no case reduced pulse rate required treatment. Monitoring of mean blood pressure was done and data was recorded for the groups at preoperative period and 5,10,15,20,30,45,60,90,120 minutes 4,6,12,18 and 24 hours after giving block.On comparison there was statistically significant difference found in both groups with respect to mean blood pressure..(p value< 0.05)



Mean arterial pressure was lower in group RD.Fall in mean arterial pressure started after 15 minutes and returned to baseline after 4 hours.Minimum mean arterial pressure noted was 86 mm of Hg.No patient required treatment.

Monitoring of respiratory rate & SpO2 was done and data was recorded for the groups at preoperative period and 5,10,15,20,30,45,60,120 minutes,4,6,12,18 and 24 hours after giving block. On comparison there was no statistically significant difference found in both groups with respect to respiratory rate (p value >0.05)

4. Discussion

Supraclavicular brachial plexus block is an excellent way of providing intraoperative anaesthesia for elbow, forearm and hand surgeries. In our study we used Dexmedetomidine in the dose of 1 microgram/kg (approximately 50 microgram). This was based on the previous study conducted by Rancourt et all.(7)

In our study, in group R and group RD 76.7% were male and 23.3% were females.Both group were comparable (p value >0.05).

All patients included in our study had weights in range of 50-70 kg. The mean weight in group R and RD was 56.97+/-5.41kg .Both groups were comparable (p value >0.05).

The average age in group R was 33.17+/-9.74 years and average age in group RD was 34.20 +/- 11.60 years.Both groups were comparable and there was no statistically significant difference among both groups (p value 0.710).

Both groups were comparable with respect to diagnosis (p value 0.934), type of surgery (p value 0.965),tourniquet discomfort (p value 1.000) , duration of surgery (p value 1.000).There was no statistically significant difference among both the groups.

Onset of sensory block was 13.00+/-2.32 min in group RD while it was 19.00+/-2.83 min in group R. This difference was statistically significant (p value <0.001).These findings correlate with the studies of Esmaoglu et al.(8) Obayah and colleagues(9),Kenan kaygusuz et al(10),Amay s Ammar and Mahmoud(11),Sandhya Agarwal et al(12)However Marhofer et al,Rancourt et al(13)in their studies found that onset of sensory blockade was similar in both study groups.In Kenan Kaygusuz et all study, onset of sensory blockade was 7.75 +/-2.22 min in patients,who received Levobupivacaine and Dexmedetomidine (100 microgram) as compared with patients received Levobupivacaine alone(10.75+/-2.55 min). (10) Sandhya Agarwal et al(12)study,onset of sensory blockade was significantly earlier in Dexmedetomidine(100 microgram) group(13.20+/-1.84 min vs 19.04 +/-3.19 min)

In Rachana Gandhi et al study onset of sensory blockade was earlier in control group as compared with Dexmedetomidine group (18.4 +/-2.5 min vs 21.4 +/-2.5 min).(14)

Onset of motor block was 19.80+/-1.90 min in group RD while it was 24.10 +/- 2.40 min in group R.This difference was statistically significant (p value <0.001).Similarly, Marhofer et al,Sandhya Agarwal et al, Ammar and Mahmoud in their study, found that that motor block onset was hastened by the use of Dexmedetomidine adjuvant in brachial plexus block with local anaesthetics.(6,11,12)In

Marhofer et al study, onset of motor blockade was significantly earlier in patients who received Dexmedetomidine (20 microgram) in peripheral nerve block(21+15 min vs 47+/-36 min).(6) Sandhya Agarwal et al noted that the onset of motor blockade with Dexmedetomidine (100 microgram) was 16.3+/-1.7 min while plain Bupivacaine having onset of motor blockade 22.7+/-2.8 min(12).Ammar and Mahmoud found that onset of motor block was earlier in dexmedetomidine group(15.3 min vs.22.2 min)(11).

In Rachana Gandhi et al study onset of motor blockade was earlier in control group than dexmedetomidine group.In this study onset of motor block was earlier than sensory block.This is explained by Core and Mantle concept .Outer motor fibers of brachial plexus from the mantle are blocked earlier than sensory fibers at core.(14)

In present study mean of total duration of sensory blockade in group R was 566.67 +/- 24.89 minutes and in group RD was 728.83+/-10.23 minutes.This difference was statistically significant (p value < 0.001). The duration of motor blockade in group R was 462.83+/-15.01 minutes and in group RD was 608.83+/-10.23 minutes.This difference was statistically significant (p value <0.05). This findings lend support to observations of various earlier studies of Esmaoglu et al,Marhofer et al,Rancourt et al, Rachana Gandhi et al,Kenan Kaygusuz et al,Ammar and Mohmoud,Sandhya Agarwal et al.(6,7,11,12,14)
We observed that sensory block lasts longer as compared to motor block which was comparable with observations by Rachana Gandhi et al.(14)

Rancourt et al, Kenan Kaygusuz et al,Sarita Swami et al,Sandhya Agarwal et al observed similar haemodynamic condition in their studies.In all these studies herat rate and mean arterial pressure was decreased in Dexmedetomidine group but no patient required treatment.(13,10,,12,15)

In group RD, patients had decreased heart rate and reduced mean arterial pressure, which may be related with systemic absorption of dexmedetomidine. Presynaptic activation of alpha 2 adrenoreceptor in central nervous system inhibits release of norepinephrine, terminating prolongation of pain signals and their post synaptic activation. Sympathetic activity thereby reduces heart rate and blood pressure.Transient hypertensive response with dose 1 -4 microgram/kg is attributed to initial stimulation of alpha 2B subtype receptor in vascular smooth muscles.Bradycardia is a reflex response to this transient response and it persists subsequently due to central sympathetic inhibition.Baroreceptor reflex and heart rate response to pressor agent is well preserved with use of Dexmedetomidine, confirming haemodynamic stability.

Respiratory rate and oxygen saturation were comparable in both the groups and there was no statistically significant difference (p value >0.05).

In present study,mean of post operative analgesia duration in group R was 576.67 +/-24.89 minutes while it was 738.83 +/-10.23 minutes in group RD. Significant statistical difference was observed in both groups with respect to mean duration of analgesia (p value <0.001).

Esmaoglu et al observed statistically significant (p value < 0.05) longer duration of post operative analgesia in Dexmedetomidine group as compared with plain Levobupivacaine(8).Obayah and colleague observed that the time for first analgesia was 22 hrs in Dexmedetomidine group compared with 14.2 hrs in plain Bupivacaine group.(9)Similar results were observed by Rachana Gandhi et al where the total duration of post operative analgesia was longer with Dexmedetomidine (732.4 +/- 98.1 min) as compared with Bupivacaine (194.8+/- 60.4 min)(14). Kenan Kaygusuz et al observed that the postoperative duration of analgesia was 1279.54 +/-138.42 min in Dexmedetomidine group as compared with Levobupivacaine (736.80 +/- 45.31 min)(10).Ammar and Mahmoud observed that total duration of post operative analgesia was longer with Dexmedetomidine (403 min) as compared with Bupivacaine (233 min)(11).Sandhya Agarwal et al observed that total duration of post operative analgesia was longer with Dexmedetomidine (776.4 +/- 130.8min) as compared with Bupivacaine (241.4 +/- 51.2 min)(12).

5. Summery

The summery of the whole study is

- There was significant difference in onset of sensory and motor block. Mean onset of sensory blockade was 13 minutes and motor blockade was 19.80 minutes in group RD was earlier than group R.
- The addition of Dexmedetomidine to local anaesthetic agent Ropivacaine used in supraclavicular brachial plexus block significantly prolonged the postoperative analgesia.
- Mean duration of post-operative analgesia in group Ropivacaine was 9.44hrs (566.67mins), while the duration was much longer, approximately 12-14 hrs (728.83 mins) in case of group Ropivacaine-Dexmedetomidine.
- There was less requirement of analgesics in first 24 hrs postoperatively in Dexmedetomidine with Ropivacaine group.
- Lower heart rate (lowest was 65/min) and mean arterial pressure (lowest was 86 mm of hg) was noted in group RD but no patient required treatment.Good haemodynamic stability was there in group RD as compared to group R.
- No any intra or postoperative complication was noted in both groups.
- The added advantage of conscious sedation was noted in group RD.

6. Conclusion

Hence, we concluded that Dexmedetomidine, when used in combination with local anesthetic agent Ropivacaine in brachial plexus block was useful in early onset of sensory and motor blockade, prolongation in duration of postoperative analgesia and significantly decreased the need of analgesics in first 24 hour postoperatively.The added advantage of conscious sedation, haemodynamic stability

and minimal side effects makes Dexmedetomidine, a potential adjuvant to peripheral nerve blocks.This helps in reducing the cost of treatment and hospital stay and makes patient more comfortable and allows early ambulation in immediate postoperative period. It can be useful in day care surgery. Limitation of this study is small sample size and may need further evaluation.

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